

When A Standard Candle Flickers: Hard X-ray Variations in the Crab Nebula



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Image Credits: X-ray: NASA/CXC/SAO/F.Seward; Optical: NASA/ESA/ASU/J.Hester & A.Loll; Infrared: NASA/JPL-Caltech/Univ. Minn./R.Gehrz

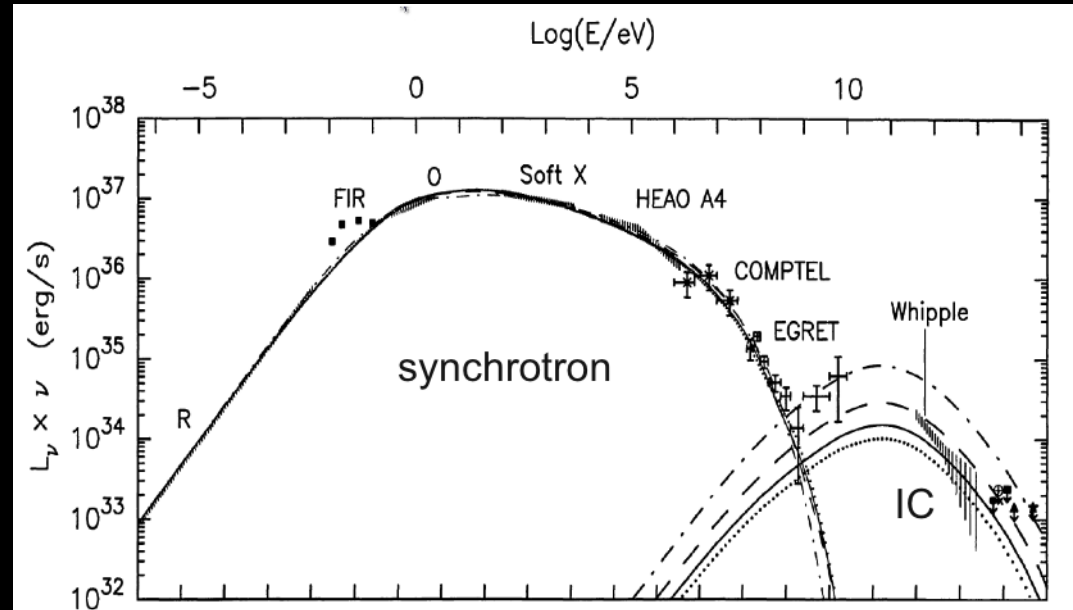
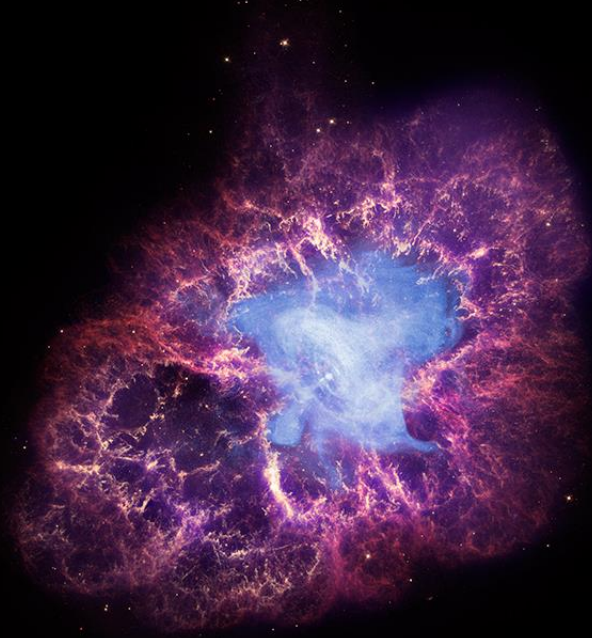
Coauthors/Collaborators

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MAXI data from <http://maxi.riken.jp>

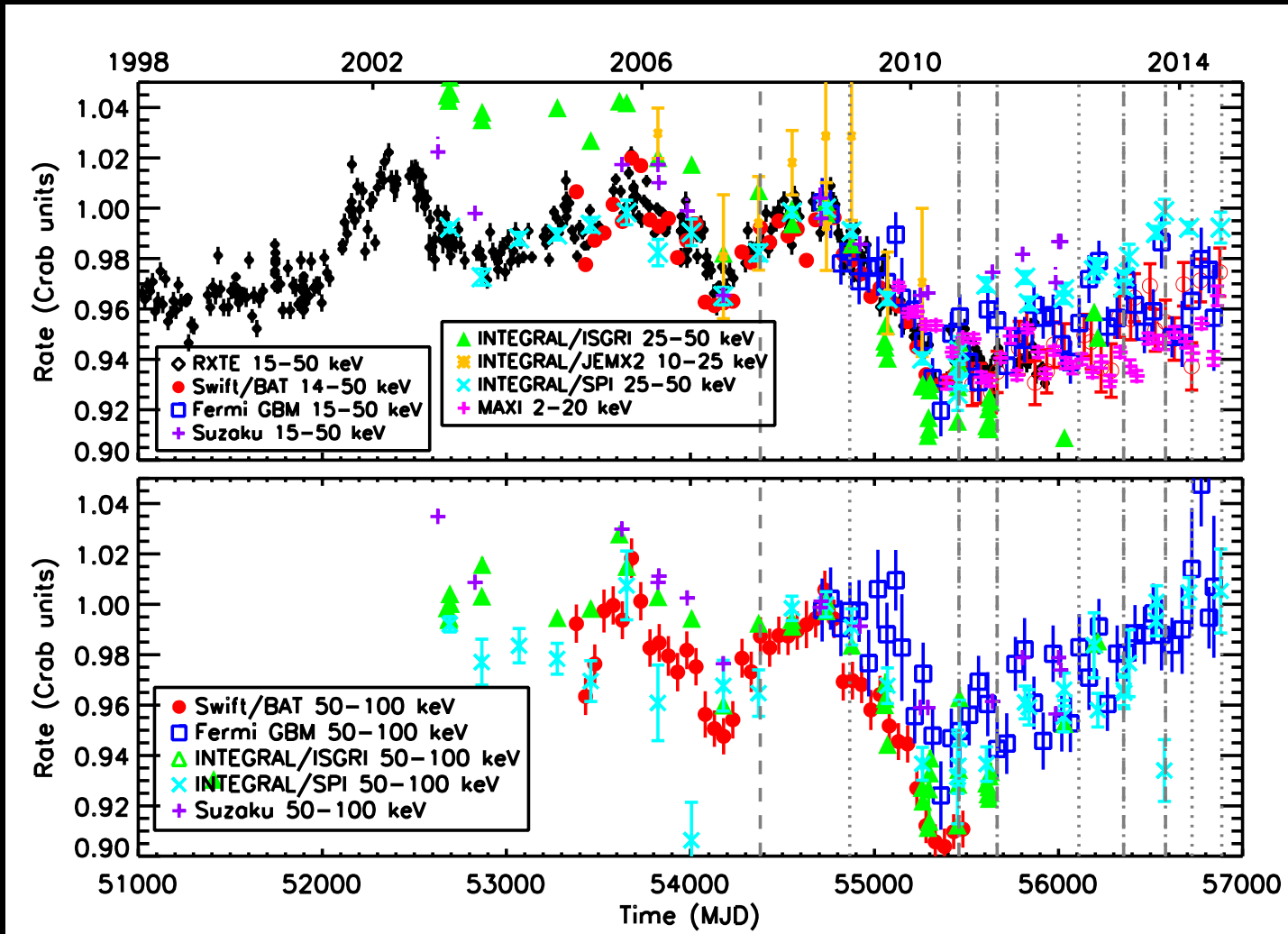
Suzaku data from Kouzu et al. 2013, PASJ, 65, 74

Introduction



- 1054 AD Supernova at 2 kpc
- Consists of a pulsar, pulsar wind nebula, and a cloud of expanding ejecta
- Energy spectrum: synchrotron & inverse Compton components

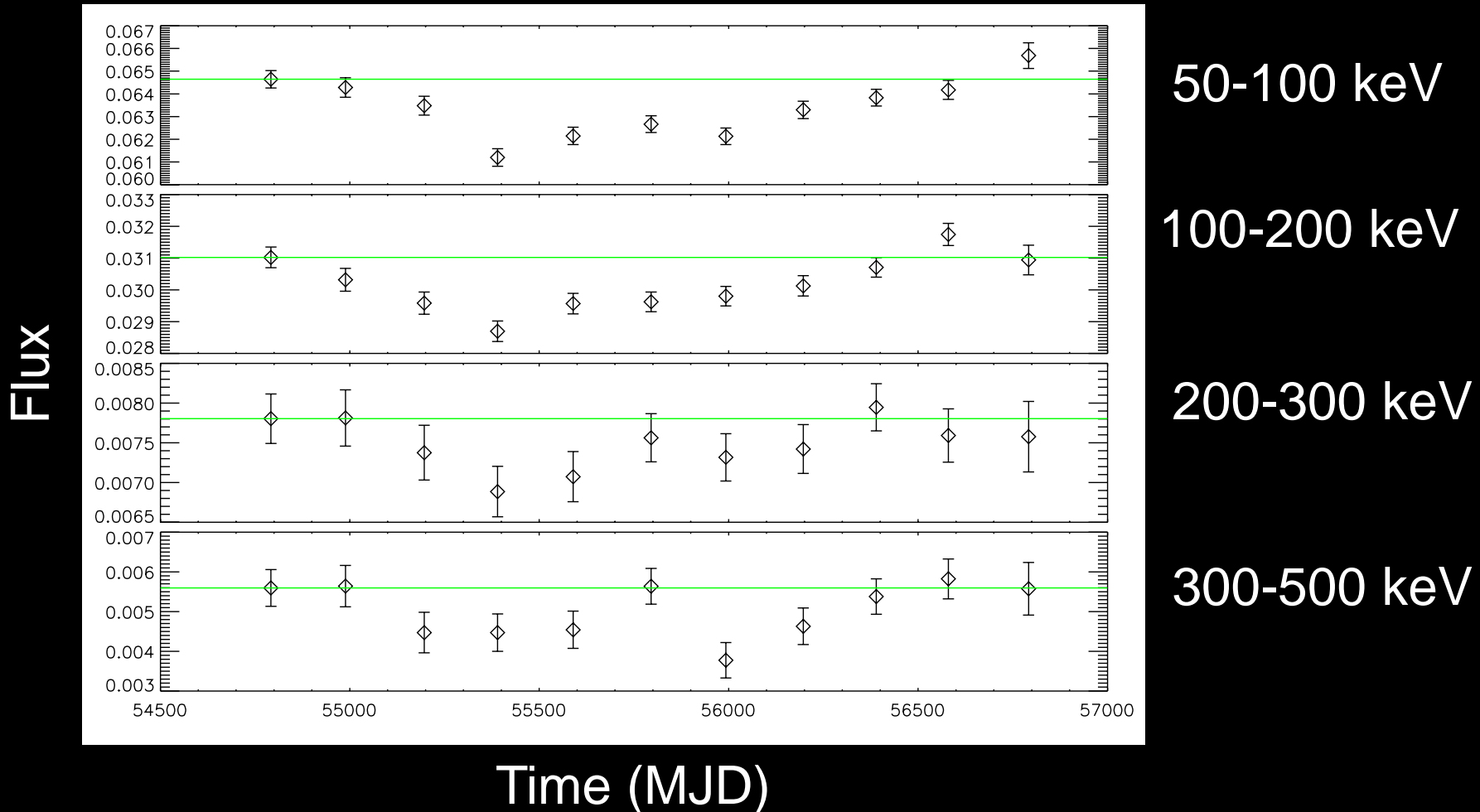
Current Hard X-ray Light Curve



GBM 100-500 keV light curves

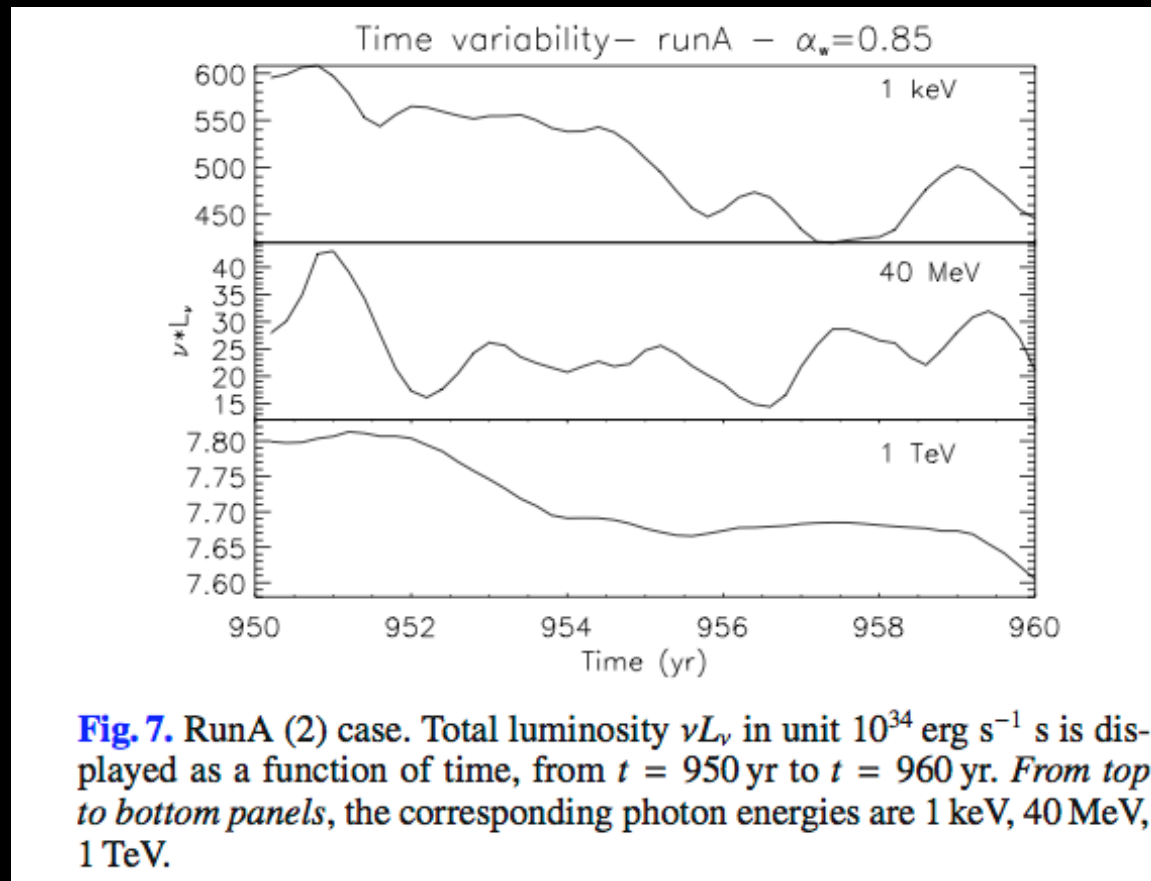
2008

2014



Predicted Time Variability

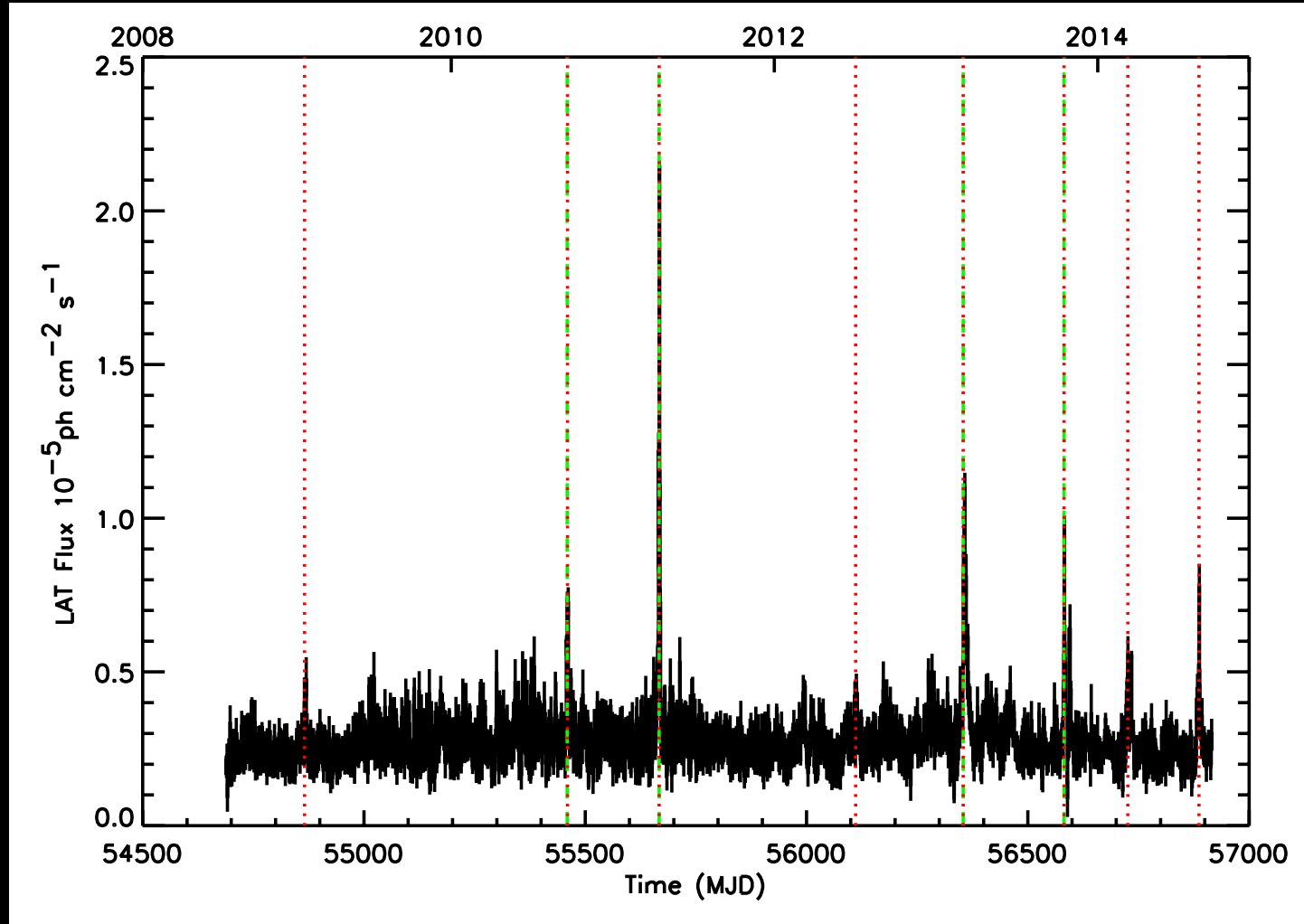
- Using MHD simulations, Volpi et al (2009) found characteristic timescales of 1-2 years at energies <0.75 MeV.
- The magnitude of the variations is larger than observed at lower energies



Volpi et al. 2009, A&A 485, 337

High Energy (MeV-GeV) Flaring

100 MeV - 300 GeV Flux (Nebula + Pulsar)



Summary & Conclusions

- The Crab Nebula shows both long-term and short timescale variability.
 - In Hard X-rays the Crab flux has returned to near 2008 levels, showing variations of up to $\sim 3.5\%$ /year
 - At higher energies, 7 flares have been reported between 2007 and 2014, seen with AGILE and Fermi LAT
- The location and mechanism producing both types of variability is still mysterious.
- Crab monitoring demonstrates the value of overlapping instruments, all-sky monitoring, and need for keV-MeV coverage